Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

Cop. 3

UNITED STATES
DEPARTMENT OF AGRICULTURE
DEPARTMENT CIRCULAR 392

Washington, D. C. July, 1926

RARE CASES OF MOSAIC DISEASE IN HIGHLY RESISTANT VARIETIES OF SUGAR CANE

P. A. YODER

Associate Technologist, Office of Sugar Plants, Bureau of Plant Industry

LIBRARY
RECEIVED
★ JUL 6 1926 ★
U. S. Department of Agriculture

CONTENTS

	Page
Earlier observations on rare cases of mosaic	1
Mosaic now found in varieties supposed to be immune	2
Extent of exposure to mosaic	3
Effect of these discoveries on future course in the sugar-cane industry	5
New highly resistant or immune varieties in prospect	6
Summary	6

EARLIER OBSERVATIONS ON RARE CASES OF MOSAIC

Prior to the summer of 1925, the time of the observations herein recorded, the opinion was generally held by cane growers and investigators that several well-known members of the group of slender fibrous sugar-cane varieties of the Chinese type were immune to the mosaic disease. Indeed, in 1919, when this disease was first definitely ascertained to be present in continental United States, the early systematic inspections of variety plots on the sugar-cane experiment fields of the United States Department of Agriculture at Cairo, Ga., and of the Louisiana Sugar Experiment Station at New Orleans, gave rise to an impression that all varieties of that type then growing in these fields were probably immune.[1] Later in the same year

---

[1] Much confusion exists in the names applied to varieties of the Chinese type of cane, mainly through the application of the name "Uba" indiscriminately to the progeny of several lots of cane, imported from widely different sources, which happen to resemble one another very closely. This is unfortunate, for the writer has evidence indicating that some of these varieties which look alike are notably different in cultural qualities and in disease resistance. The following notes on names and importation history will help to identify the particular varieties and strains included in this report. With the exception of the Old Small Japanese, all these varieties are so similar that it would be difficult, if not impossible, to distinguish them as they are growing in the field.

Old Small Japanese.—This is the Japanese cane that has been grown for many years in the Gulf States for forage and for sirup. It was procured from a neighbor for the field station at Cairo, Ga., in the spring of 1916. It is decidedly more slender in stalk and leaves and the joints are more enlarged than any of the other varieties here discussed.

Cayana (originally called Cayana-10).—Two cuttings imported by the U. S. Department of Agriculture in April, 1914, under S. P. I. No. 38902 (S. P. I. denotes Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry) from the Centro Agricola

(August 14, 1919) the writer found a prominent case of the characteristic leaf-mottling symptoms of mosaic on one variety of this type of Japanese origin, the Kikaigashima.[2] Shortly after this the writer observed the symptoms also on other varieties of this type, also of Japanese origin, including the Oshima, Yontanzan, and Chikucha, and similar observations were reported to the writer by E. W. Brandes. In 1921, successful experiments were made by Brandes and Klaphaak [3] in transmitting the mosaic to five varieties of this type—Khera, Chikusho (Tekcha), Kagawa Ken, Kikaigashima, and Chikucha. Transmission experiments at the same time gave negative results with Uba, Kavangire, Cayana, Merthi, Kinar, and Oshima.

MOSAIC NOW FOUND IN VARIETIES SUPPOSED TO BE IMMUNE

The more frequently mentioned varieties of the slender fibrous Chinese type, which were generally thought to be immune to mosaic, are Uba, Cayana, Kavangire, and Old Small Japanese, all of which are in the collection at Cairo, Ga. Up to the autumn of 1924, the mosaic had not been observed in these varieties, so far as the writer

---

at Bahia, Brazil. The progeny was all sent to Cairo in May, 1916, when released from quarantine at Washington. Because other Cayana varieties imported with Cayana–10 have since been eliminated, the distinguishing number 10 may be dropped in the name of this single Cayana variety retained.

Uba.—Twelve cuttings received from Natal through Pretoria, Transvaal, South Africa, September, 1915, imported under S. P. I. No. 41154. The progeny, after release from quarantine in the spring of 1917, was divided between the station at Cairo, Ga., and the Louisiana Sugar Experiment Station at Audubon Park, New Orleans.

Khera.—Imported from Aligarh, United Provinces, India, in 1912, under S. P. I. No. 33242, and planted at the Cairo station first in 1917.

Yontanzan.—Nine cuttings imported from Okinawa Ken, Kiushu, Japan, through the Yokohama Nursery Co., June, 1910, under S. P. I. No. 28193. It was sent by the U. S. Department of Agriculture to the Florida Agricultural Experiment Station and from there was sent to the field station at Cairo, Ga., in March, 1918. The name supplied on the importation card is "Yomitani yama." This name, as explained to the writer by Japanese visitors (Kumanosuke Teniguchi, of Japan, and Masao Yoshikawa, of the United States Department of Agriculture, Washington), is a pure Japanese pronunciation of the Japanese or Chinese characters used in the name. The pure Chinese pronunciation of the same characters is "Yontanzan," but the name actually used for the variety in Okinawa Ken by both the native inhabitants and the Japanese sugar-cane people is "Yontanza." Since, however, the name "Yontanzan" has already entered the English literature on sugar cane, the writer chooses to retain it.

Tekcha.—Imported from Japan through the Yokohama Nursery Co. in December, 1910, under S. P. I. No. 29106. It reached the Cairo station through the same route as the Yontanzan. (See above.) The name supplied on the importation card is "Chikusho." This is probably an erroneous pronunciation of the two native Chinese or Japanese characters meaning bamboo ("chiku" in Japanese and "teki" in Formosan Chinese) and cane ("sho" in Japanese and "cha" in Formosan Chinese). As the name "Tekicha" or "Tekcha" is a familiar name of a cane variety in Formosa, and as this name is also adopted by the Japanese, the writer assumes that the correct name is "Tekcha."

Kikaigashima.—Imported from Kagoshima Ken, Japan, through the Yokohama Nursery Co., December, 1910, under S. P. I. No. 29108. Received at Cairo station in January, 1918, from the plant introduction field station of the U. S. Department of Agriculture at Brooksville, Fla.

Oshima.—Imported from Kagoshima Ken. Japan, through the Yokohama Nursery Co., December, 1910, under S. P. I. No. 29109. Received at the Cairo station in March, 1919, from Henry C. Bystra, Brooksville, Fla., who got it from the Florida Agricultural Experiment Station, to which station it was sent by the U. S. Department of Agriculture.

Chikucha.—Imported from Tainan, Formosa, Japan, April, 1911, under S. P. I. No. 30464. It reached the Cairo station through the same route as Yontanzan. (See above.) This name supplied on the importation card is probably an erroneous combination of a Japanese pronunciation ("chiku"=bamboo) of one native character and a Chinese pronunciation of another character ("cha"=cane) and should probably be given the Formosan Chinese pronunciation Tekicha or Tekcha. (See also Tekcha above.) It is probably a different strain of the familiar Tekcha variety. It differs in physical characteristics, especially in width of leaves, from the Tekcha imported under S. P. I. No. 29106, mentioned above. For want of a better distinguishing name, Chikucha is retained in this report.

Kavangire.—Imported from Tucuman, Argentina, in the summer of 1919, under S. P. I. No. 48076, and planted at Collins Key, near Miami, Fla., and from there sent to the Cairo station in the autumn of 1920 and planted in the spring of 1921.

[2] YODER, P. A. GROWING SUGAR CANE FOR SIRUP. U. S. Dept. Agr., Farmers' Bul. 1034 (rev.): 1922, p. 29.

[3] BRANDES, E. W., and KLAPHAAK, P. J. CULTIVATED AND WILD HOSTS OF SUGAR-CANE OR GRASS MOSAIC. Jour. Agr. Research 24: p. 255. 1923.

is aware. During that autumn the writer's attention was called to mosaic symptoms of a stool of Uba at the sugar-cane experiment field at Cairo by an employee, B. A. Belcher. The leaves presented the distinct mottling characteristic of the mosaic disease. This case was so unusual that it suggested a possible accidental admixture of another variety on the plot. Other duties prevented immediate further inspections at this time, and a systematic inspection planned for other plots of this variety and of other varieties of this type during the same season was frustrated by an unexpected early frost which killed the leaves.

During the summer of 1925, however, while the cane was at an earlier stage of growth and the mosaic was more easily distinguishable, the writer made a close inspection of many plots of this variety and of all the other varieties of this type on the experiment farm. A few stools with the characteristic mottling of mosaic were found not only in the Uba cane but also in all the other imported varieties of this type on the farm, including Old Small Japanese, Cayana, and Kavangire, hitherto regarded as immune. In the case of the Cayana, many plots of from 0.03 to 0.05 acre were closely scrutinized before the first case was found. In a few such plots, however, there were found from three to six stools of mosaic. In the case of the other varieties mentioned above as hitherto considered immune the cases were not quite so rare, compared with the area planted.

In the same close inspection of the other highly resistant varieties of the Chinese type, imported from Japan in 1910 and 1911, the cases of mosaic were found to be distinctly more abundant. This includes Yontanzan, Tekcha, Kikaigashima, Oshima, and Chikucha. With these varieties most of the plots of from 0.03 to 0.05 acre presented one or more cases, some of the plots from 5 to 20 cases.

It is not possible to judge conclusively the degree of resistance to mosaic in these varieties from the extent of the infection observed this single year (1925) without also having a fuller record than is now available of exposure of the individual varieties during previous years. However, it will afford some indication as to probable relative degree of resistance to note that, in rareness of infected stools in plots approximately equally near to highly susceptible varieties in 1925, these resistant varieties stood in the following order: Cayana, Uba, Tekcha, Kavangire, Khera, Chikucha, Yontanzan, Oshima, Kikaigashima, Old Small Japanese. Of these varieties, only Cayana, Uba, Tekcha, and Yontanzan were available for observation in a large number of plots, scattered over various parts of the field. Of the other varieties mentioned, the plots available were so few in number that these observations have less conclusive significance with respect to degrees of susceptibility. It was noted that all the varieties of Japanese origin were much higher in mosaic cases than Cayana and Uba.

EXTENT OF EXPOSURE TO MOSAIC

All of these highly resistant varieties have been grown for a number of years adjacent to cane of the large-stalk, broad-leaf varieties having a high percentage of mosaic. There is evidence that the mosaic disease was introduced on the experiment farm at Cairo, Ga., in 1916 on cane originating in Louisiana. The Old Small Japanese and the Cayana were on this farm from the same year and therefore have been exposed ever since that time. The Uba and Khera were started on this farm the succeeding year, 1917. Of the later Japanese introductions, the Yontanzan, Tekcha, and Kikaigashima were first planted at Cairo in the spring of 1918 and the Oshima in the spring of 1919. The Kavangire was first planted here in 1921.

In 1919, when mosaic was discovered on this farm, the more highly susceptible varieties, such as Home Purple, Ribbon, Home Green, Green Ribbon, D–74, D–95, and L–511 growing on the farm had from 20 to 80 per cent of the stools infected with the disease. By 1921, of these varieties that were still grown at this field station, Home Purple and L–511 had about 100 and 50 per cent, respectively, of infected stools. From 1921 only relatively small areas on the experiment farm were planted in these highly susceptible varieties, though neighboring farms continued to have an abundance of the Home Purple cane with practically 100 per cent infection. The experiment farm was planted mainly with the highly resistant varieties of the Chinese type. In 1922 and 1923, Java seedlings susceptible to mosaic—P. O. J. 36, P. O. J. 213, P. O. J. 228, P. O. J. 234—and several others from Java were introduced on the farm in small quantities. In 1924 and 1925 large numbers of United States seedlings were introduced on this farm, and among them were many that promptly became infected with mosaic.

Among the resistant varieties of the Chinese type, the number of cases found on plots remote from the more susceptible varieties, like the Home Purple, were notably rarer than on plots adjacent, although in the case of the Cayana such relationship could not be detected. In the latter variety the cases were very rare throughout except on a few plots, and those plots were relatively remote from highly susceptible varieties.

In 1919, when mosaic was discovered at Cairo, all varieties of the thick-stalk, broad-leaf type, the so-called " noble " varieties, then in the collection at the field station were without exception found infected with the mosaic. This included Home Purple (Louisiana Purple, Red, Black Cheribon), Ribbon (Red Ribbon, Louisiana Striped, Rayada), Home Green (Green, Otaheite, Bourbon), Green Ribbon (Simpson), Crystalina (White), Palfrey, D–74, D–95, D–1135, L–511, L–218, L–219, L–226, L–231, L–253, Cayana–2, Cayana–3, Cayana–4, Cayana–6, Cayana–7, Cayana–8, Cayana–11, Cayana–13, Cayana–14, Cayana–17a, Cayana–17b, and several others in smaller quantities. Many of these were 100 per cent infected in 1919 and for that reason were totally eliminated from the collection at the close of the 1919 season. After 1920, on removal of the experiments to another farm also near Cairo, only Home Purple and L–511, as mentioned above, were continued.

During the seasons of 1919 and 1920 thoroughgoing inspections were made by the writer of all plots of the varieties of the Chinese type then on the farm, and it is therefore not probable that any of them had stools showing infection except those of Japanese origin already mentioned. After 1920 the inspections were of a more casual nature, but sufficiently detailed to make it seem improbable that there was much infection in any of the varieties before 1924. It seems probable therefore that the incidence of the disease in these varieties was largely in 1924 and 1925.

It is not in the province of this circular to offer any explanation accounting for the difference between the amounts of infection in these varieties observed in 1925 and those observed in earlier years. Whether the seasonal conditions were more favorable for infection, whether the insect carrier became more abundant, whether a more effective carrier came in, whether a more virulent form of the disease itself came in, whether it is a more or less erratic development through agencies continually on hand, or whether it is due to some other cause or combination of causes must remain for future investigations to answer. That the differences in the observations reported are due to differences in the thoroughness of the inspections seems improbable from what was said in the last preceding paragraph. That these recent cases observed are due to an accidental admixture of more susceptible varieties with the highly resistant or immune varieties seems highly improbable, because of the extreme care always exercised on this experiment farm in keeping varieties separate, and because of the fact that this new incidence of mosaic is not limited to one or a very few varieties but applies to all the imported varieties of that type on hand, including the Old Small Japanese cane, which, in size and shape of stalk and leaves, differs so widely from the other varieties grown on the farm that an admixture could readily be detected. That the diagnosis as mosaic is erroneous seems improbable, for the markings on the leaves corresponded with those of mosaic in varieties known to be susceptible, and these plants presented a clear and strong contrast with others of the same varieties adjacent, which were judged to be free from mosaic. This diagnosis was concurred in by several others who had extensive experience with mosaic in sugar cane, including R. D. Rands and P. J. Klaphaak, as well as several employees on the farm.

EFFECT OF THESE DISCOVERIES ON FUTURE COURSE IN THE SUGAR-CANE INDUSTRY

Although it is somewhat startling to discover of a sudden that some popular varieties long thought to be immune[4] are not, this need not necessarily have any serious effect upon practical sugar-cane culture. So far as yield is concerned with any of these highly resistant varieties, they may still be considered as good as immune. The number of cases appearing in the varieties formerly supposed to be immune is so extremely small and the evidence of any stunting effect so meager that it can not have any appreciable effect on the yield, even if the incidence of the disease in a plant does have a stunting effect.

---

[4] Absolute immunity of a variety of plants or animals to a specific disease means that that variety is incapable of contracting that disease under any circumstances. In this sense it is doubtful whether the term can be applied with absolute certainty to any variety of plants or animals with reference to any disease to which its species is susceptible. In common usage, therefore, the term must be understood to imply merely that it is known that individuals of the variety have been abundantly exposed to infection without contracting the disease and that no cases have been observed in which individuals of the variety have contracted it. In one sense the use of the term "immune" is analogous to the practice, in legal parlance, of considering the defendant innocent until proved guilty.

However, in one respect these observations may have an important bearing on future course of action. We can no longer rest assured that we have totally eliminated mosaic of the sugar cane simply by planting exclusively the Old Small Japanese, the Cayana, the Uba, or the Kavangire variety. On this point it should be remembered, however, that with these varieties effective roguing out of the diseased stools should easily be feasible, because of the relatively rare cases of infection. The possibility is not excluded even that by persistent roguing or, more likely, by single-eye progeny selection a strain that is actually immune can be separated from one of these varieties.

NEW HIGHLY RESISTANT OR IMMUNE VARIETIES IN PROSPECT

Although these 10 imported varieties of the Chinese type can no longer be considered absolutely immune, there are scores of varieties of cane in the collections at Cairo, Ga., Canal Point, Fla., Houma, La., and Baton Rouge, La., which, up to date, have not shown any evidence of mosaic and are therefore considered immune. Several such are imported varieties, but many more are seedlings produced at Canal Point, Fla., by the Office of Sugar Plants of the Bureau of Plant Industry, United States Department of Agriculture, cooperating with the Louisiana Experiment Station. Hundreds of these are being tested at Cairo, Ga., cooperating with the Cairo Cane Growers' League; at Houma, La., cooperating with the American Sugar Cane League; and at Baton Rouge, La., cooperating with the Louisiana Experiment Station. Although most of these apparently immune seedlings are too low in sugar content or too slender and fibrous to be good commercial varieties, a few are of sufficiently high quality to come under consideration as a commercial possibility, or at least to give grounds to hope that through seedling production and testing a good commercial variety can be found that is at the same time immune to mosaic.

SUMMARY

Well-known varieties of sugar cane of the slender, fibrous, prolific type, the Chinese type, are known to be highly resistant to mosaic. They were at one time thought as a class to be immune, but rare mosaic cases were observed in some members of the groups of Japanese origin shortly after the mosaic was discovered in the sugar cane in continental United States. Up to 1924, rare cases of mosaic had been observed on the Kikaigashima, Oshima, Yontanzan, Chikucha, Chikusho (Tekcha), and Kagawa Ken of Japanese origin and the Khera of Indian origin. The Uba, Cayana, Kavangire, and Old Small Japanese are well-known members of this group that were hitherto generally thought to be immune.

In the fall of 1924 the writer observed a case of mosaic in Uba at Cairo, Ga., and during the succeeding summer a systematic search through the experiment plots at the sugar-cane field station at Cairo revealed cases of mosaic in all the above varieties hitherto thought immune, and more numerous cases in the other varieties mentioned of this type than had been observed previously. In resistance to mosaic as evidenced by the rareness of cases found in this inspection in comparison with areas planted, the varieties of this type then grown at Cairo stood in the following order: Cayana, Uba, Tekcha, Kavangire, Khera, Chikucha, Yontanzan, Oshima, Kikaigashima, Old Small Japanese.

These varieties had been exposed to mosaic infection in the Cairo collection as follows; Old Small Japanese and Cayana since 1916; Uba and Khera since 1917; Yontanzan, Tekcha, and Kikaigashima since 1918; the Oshima since 1919; and the Kavangire since 1921.

Because of the scant amount of infection and the lack of evidence of any serious stunting effect on these varieties which were formerly thought to be immune, they can still be considered as good as immune so far as yields are concerned, but the fact that they are susceptible must be taken into consideration in proposed distributions to noninfected localities and in programs of total elimination of mosaic from a locality by planting only these varieties. Because of rareness of cases, a roguing program should easily be effective in eliminating mosaic from these varieties.

A few other new varieties have been imported, and many more that are highly resistant or immune to mosaic have been produced from seed at Canal Point, Fla., and are being tested, and there are good prospects that other successful commercial varieties will result from this work.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

June, 1926

Secretary of Agriculture	W. M. Jardine.
Assistant Secretary	R. W. Dunlap.
Director of Scientific Work	————
Director of Regulatory Work	Walter G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Information	Nelson Antrim Crawford.
Director of Personnel and Business Administration	W. W. Stockberger.
Solicitor	R. W. Williams.
Weather Bureau	Charles F. Marvin, *Chief.*
Bureau of Agricultural Economics	Thomas P. Cooper, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Forest Service	W. B. Greeley, *Chief.*
Bureau of Chemistry	C. A. Browne, *Chief.*
Bureau of Soils	Milton Whitney, *Chief.*
Bureau of Entomology	L. O. Howard, *Chief.*
Bureau of Biological Survey	E. W. Nelson, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Bureau of Dairying	C. W. Larson, *Chief.*
Fixed Nitrogen Research Laboratory	F. G. Cottrell, *Director.*
Office of Experiment Stations	E. W. Allen, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Library	Claribel R. Barnett, *Librarian.*
Federal Horticultural Board	C. L. Marlatt, *Chairman.*
Insecticide and Fungicide Board	J. K. Haywood, *Chairman.*
Packers and Stockyards Administration	John T. Caine, III, *in charge.*
Grain Futures Administration	J. W. T. Duvel, *in Charge.*

This circular is a contribution from

Bureau of Plant Industry	William A. Taylor, *Chief.*
Office of Sugar Plants	E. W. Brandes, *Senior Pathologist in Charge.*

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY
▽